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(54) METHOD AND APPARATUS FOR SEPARATING PHASES OF A MULTI-PHASE LIQUID

VERFAHREN UND VORRICHTUNG ZUR PHASENTRENNUNG EINER MEHRPHASIGEN FLÜSSIGKEIT

PROCEDE ET APPAREIL DE SEPARATION DE PHASES D'UN LIQUIDE A PHASES MULTIPLES

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- **DERWENT ABSTRACTS Accession No. 88-219334/31, Class J01, SU,A, 1368044 (Mosciw Steel Alloys Inst) 23 January 1988 (23.01.88)**
- **DERWENT ABSTRACTS Accession No. 87-071292/10, Class 41, SU,A, 1244101 (ESIPOVICHI YA) 15 July 1986 (15.07.86)**

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Description

This invention relates to a method of and apparatus for separating phases of a multi-phase liquid.

Particularly, but not exclusively, the invention concerns separation of a water component from an oil-water mixture such as the production liquid from an oil well head. Characteristically, such liquid contains substantial quantities of gas and water in admixture with oil components and as a first step in the production process it is usual to undertake a separation process which has as its object to remove substantial quantities of the gas and water so as to obtain an output liquid in which the oil at least predominates and at least the water component is reduced to a relatively small fraction.

Conventionally, the above described separation is effected in a separation tank in which the water component settles to the bottom of the tank, from which it can be readily drawn off. Such tanks are, however, bulky, heavy and generally inconvenient of use, particularly in circumstances, such as on off-shore oil platforms, where space and weight constraints are important factors.

It has been proposed to use cyclone separators for separating oil and water components from a mixture thereof, and such separators are coming into increasing use because of the considerable efficiency they can possess and the generally smaller and lighter separating facilities which can be constructed using them. Principally, however this use is confined to separating processes further removed from the initial separating process above described. In that regard, the water component, once removed by the initial separating process, will contain some residual oil, typically a few percent, and it is in the separation of this residual oil that cyclone separators have thus far found principal application.

The failure of the cyclone separator to thus far become widely used for the initial separation of water from production liquid, notwithstanding the advantages to be attained from such use, arises because it has not been found possible to design cyclone separators which can effectively operate on the production liquid. In part, this is because it appears generally more difficult to design effective separators for dealing with high oil concentrations ("dewatering" separators) than it is to design separators for dealing with high concentrations of water ("de-oiling" separators). In part too, the problem appears to arise because of the greater variation in composition of the production flow liquid as compared to the relatively lesser variation in composition of the liquid upon which deoiling separators usually operate. De-oiling separators typically operate on a liquid which is predominately water with a few percent oil and they are effective to reduce the oil content to a few tens of parts per million. On the other hand, dewatering separators may be called on to separate an oil/water mixture having a water content varying between 20 to 70%. At least adaptions of designs suitable for deoiling applications can be made effective for mixtures with water contents at the lower end of the last-mentioned range, but these may not always be effective for handling water contents at the upper end of this range.

In the use of cyclone separators for separation of liquid mixtures, in the event that separation efficiency drops and contamination of the material issuing from an outlet is too high, it is customary to recycle that material to the cyclone separator for further treatment. Such recycling is continued until the separation efficiency is restored. Such a method of operation and a separation system operating according to the method is, for example, described in WO-A-85/00851.

This invention is based on the observation that separation efficiency can be readily and substantially instantaneously restored by monitoring the degree of contamination of at least one of the outlet streams and using the information obtained adjusting the composition of the inlet material by addition thereto of a determined amount of one or other of the components of the mixture to be separated.

According to a first aspect of the present invention, there is provided a method of separating components from a liquid mixture by use of a cyclone separator, including determining the efficiency of separation of at least a first of the components from the mixture and upon determination that the efficiency has deviated from a predetermined efficiency value adding to the incoming mixture to the separator a quantity of one of said components to tend to cause the efficiency to revert to the predetermined value, said added quantity depending on the deviation.

According to a second aspect of the present invention, there is provided a separating apparatus comprising a cyclone separator having inlet means for a mixture of liquids to be separated and at least two outlets for outlet of respective components of the mixture, which components differ in density, the apparatus further including supply means for supply of a quantity of one of said components and means for selectively mixing an amount of said one component from the supply means to the mixture prior to admission to the separator, the apparatus also including control means adapted to effect admixture of said one component to the mixture in a fashion tending to maintain constant the separating efficiency of at least a first of said components of said mixture and sensing means positioned to be subjected to the separated flow of the first component for sensing the purity thereof, the control means being responsive to the sensing means to vary said quantity of the admixed one component depending on the sensed purity.

The method and apparatus of the invention may also be adapted to effect additions of a selected one of more than one of the components or to effect addition of different components. Similarly the control means may be responsive to purity sensors positioned to sense the purity of more than the first separated component.

The invention is further described, by way of example only, with reference to the accompanying drawing, the single figure of which is a schematic representation

of a separating apparatus constructed in accordance with the invention.

The separating apparatus 10 shown comprises a cyclone separator 12 having an inlet 14, for inflow of a multi-component liquid to be separated, an overflow outlet 16, for outflow of a lighter component of the inlet liquid, and an underflow outlet 18 for outflow of a heavier component of the inlet liquid. In this case, the inlet liquid is shown as comprising production liquid 22 from an oil well (not shown). This liquid is conveyed via a duct 20, having two mixing valves 24, 26 therein to the separator inlet 14. If necessary, a pump may be included in the duct 20 to bring the pressure and volume flow of the inlet liquid to values suitable for the operation of the separator 12.

The separator may be designed along similar lines to the deoiling separators described in United States Patents 4,237,006, 4,576,724 and in International application PCT/AU85/00010, for example, although some modifications may be desirable in order to take account of the fact that it may be desirable to optimise the separator for operation on inlet liquids having somewhat higher oil concentrations than these separators are generally optimised for. Particularly, the overflow outlet 16 may require considerable increase insofar as the cross-sectional area thereof is concerned.

The separator 12 operates in conventional fashion, the liquid 22 being admitted tangentially into an elongate tapered separating chamber in such a fashion as to direct the denser water component 28 out the axially positioned underflow outlet 18 and to direct the less dense oil component 30 out the axially positioned overflow outlet 16. As shown, the outlets 16, 18 are at opposite ends of the separating chamber, the outlet 18 being at the smaller diameter end of the separating chamber and the outlet 16 being at the larger diameter end, towards which end the inlet 14 is likewise positioned.

The separated water from separator 12 is directed from the apparatus 10 via a duct 32, such as for further processing. The separated oil from the separator is directed from the apparatus 10 via a duct 34, likewise for further processing. In practice, gas and other lighter components may likewise be passed in admixture with the oil from outlet 16 to duct 34. Some at least of these other components may be separated by interposition of further separators or other equipment in duct 34, but whether or not such further separators or other equipment are included is not important for the purposes of the present invention.

Ducts 32, 34 include therein respective contaminant sensors 38, 40. Sensor 38 acts to measure the relative degree of contamination of the water flowing in duct 32 by oil, whilst sensor 40 acts to measure the relative degree of contamination of the oil flowing in duct 34 by water. Suitable sensors may operate to measure contamination by measurement of the optical density of the liquids as flowing in the ducts 32, 34 or as flowing through suitable diverter ducts.

Electrical outputs of the sensors 38, 40 indicative of the relevant contaminant levels, are passed on lines 44, 46 respectively to a control device 48.

The apparatus further includes reservoirs 50, 52 which respectively contain quantities of water 28a and oil 30a. These reservoirs 50, 52 communicate with mixing valves 24, 26 via respective further ducts 54, 56. These ducts include respective pumps 58, 60. The valves 24, 26 and pumps 58, 60 are electrically controllable under influence of signals from control device 48 delivered thereto on respective lines 62, 64, 66, 68.

In operation, under conditions where the sensors 40, 38 provide control device 48 signals indicative an increase in contamination of either the oil 30 exiting the separator 12 via outlet 16 or of the water 28 exiting via outlet 18, the control device 48 is effective to operate either pump 60 and valve 24 or pump 58 and valve 26 to pump liquid from the respective reservoir 52, 50 to be mixed via the respective mixing valve 24, 26 with the incoming liquid to the separator, in duct 20.

This control may be effected as desired in accordance with any suitable regime, for example in the instance where the purity of oil emerging from the separator is of primary concern, and it is known that separating efficiency loss, insofar as the outgoing oil purity is concerned, is due to increase in the quantity of oil in the incoming liquid above a predetermined level, the control device 48 may simply be responsive to output from sensor 40 to operate valve 26 and pump 58 whereby to increase the proportion of water in the incoming liquid until such time as the oil outflow contaminant level drops. In such case, the valve 24 and pump 60 may be omitted, or the control device 48 may operate valve 24 and pump 60 only as a secondary control when required. Such additional control may however be required (or may be provided alone) if the characteristics of the separator 12 are such that separating efficiency drops off with low water concentrations in the incoming liquid. In this case, too, it may be desirable to provide a suitable sensor in duct 20 effective to provide an output indicative of the oil/water ratio in the incoming liquid, the control device in that case being responsive to that output to facilitate determination by the control device as to whether addition of oil or addition of water is required to optimise operation. In other embodiments, the sensors 38 and 40 are omitted, the control device operating in accordance with sensed oil/water ratios in the incoming liquid in duct 20 to maintain the oil/water ratio within a desired range, by addition of water or oil to the incoming liquid, as required.

The reservoirs may be maintained topped up by inlet from external water and oil sources, via the inlet ducts 69, 70 shown. Alternatively, as shown, bleed ducts 71, 72 may be provided communicating with oil duct 34 and water duct 32, respectively, these including respective valves 74, 76 which are controlled as necessary by control device 48 to bleed oil and water from the ducts 34, 32 via the bleed ducts 72, 71 to the respective reservoirs 52, 50.

The invention also has application otherwise than for optimising operational efficiency of separator 12 as referenced to varying inlet oil/water concentrations. For example, the separation of production liquid into oil and water components is rendered less efficient where the liquid contains grit or like particles. However, the separation efficiency may in that case be improved by admixture of oil to increase the oil concentration in the incoming liquid. In another aspect, the invention therefore further provides a method of separating components from a liquid mixture by use of a cyclone separator comprising the step of determining the presence of grit or like particles in said mixture and adding to said mixture a quantity of at least one of said components or determining such presence. The invention also provides apparatus for carrying out this method.

Furthermore, the teachings of the invention are especially applicable to separating techniques for separating liquid mixtures having a dispersed phase and a continuous phase where the addition effected to the mixture to be separated is of a liquid which is the same as or similar to that one of the liquids in the mixture which comprises the dispersed phase. Thus, for oil-water mixtures where oil is the dispersed phase, oil is added, whereas for oil-water mixtures where water is the dispersed phase, water is added.

More generally, the invention also contemplates addition of other materials, such as surfactants or the like, responsive to determination of inlet or outlet conditions in a cyclone separator.

The described construction has been advanced merely by way of explanation and many variations and modifications may be made thereto without departing from the scope of the invention as defined in the appended claims.

Claims

1. A method of separating components from a liquid mixture by use of a cyclone separator, including determining the efficiency of separation of at least a first of the components from the mixture and upon determination that the efficiency has deviated from a predetermined efficiency value adding to the incoming mixture to the separator a quantity of one of said components to tend to cause the efficiency to revert to the predetermined value, said added quantity depending on the deviation.

2. A method according to claim 1, wherein the one component is added when the efficiency departs in one sense from the predetermined efficiency value, the method further including adding to the incoming mixture another of the components when the efficiency has departed from the predetermined efficiency value in a sense opposite to the one sense.

3. A method according to claim 1 or claim 2, wherein the first component comprises the one component.

4. A method according to claim 1 or claim 2, wherein the first component comprises a component of the mixture other than the one component.

5. A method according to any one of claims 1 to 4, further including determining the efficiency of separation of a second of the components of the mixture and upon determination that the efficiency of separation of the second component has deviated from a further predetermined efficiency value, adding to the incoming mixture a quantity of a component other than the one component, to tend to cause the efficiency of separation of the second component to revert to the further predetermined value, the added quantity depending on the deviation.

6. A method according to claim 5, wherein the first and second components comprise the one component and the another component respectively, or the another and the one component respectively.

7. A method according to any one of the preceding claims, wherein the mixture is an oil-water mixture, the oil and water being disperse and continuous phases of the mixture respectively, and the one component comprises oil.

8. A method according to any one of claims 1 to 6, wherein the mixture is an oil-water mixture, the oil and water being continuous and disperse phases respectively, and the one component comprises water.

9. A method according to claim 7 or claim 8, wherein the water predominates in the mixture.

10. A method according to any one of the preceding claims, wherein the added one component is obtained by separation from the mixture.

11. A separating apparatus comprising a cyclone separator having inlet means for a mixture of liquids to be separated and at least two outlets (16,18) for outlet of respective components of the mixture, which components differ in density, the apparatus further including supply means (50,52) for supply of a quantity of one of said components and means (54,56) for selectively mixing an amount of said one component from the supply means (50,52) to the mixture prior to admission to the separator, the apparatus also including control means (48) adapted to effect admixture of said one component to the mixture in a fashion tending to maintain constant the separating efficiency of at least a first of said components of said mixture and sensing means (38,40) positioned to be subjected to the separated flow of said first component for sensing the purity thereof, the control means (48) being responsive to the sensing

means (38,40) to vary said quantity of the admixed one component depending on the sensed purity.

12. An apparatus according to claim 11, including further supply means (50,52) for supply of a quantity of another of the components and means (54,56) for selectively mixing an amount of the other component from the further supply means (50,52) to the mixture prior to admission to the separator (12).

13. An apparatus according to claim 12, wherein the control means (48), adapted to effect admixture of the other component with the mixture in a fashion tending to maintain the separating efficiency of the first and/or a second of the components comprising the mixture, the apparatus further including further sensing means (38,40) positioned to be subjected to the flow of separated second component for sensing the purity thereof with the control means (48) being responsive to the further sensing means (38,40) to vary the quantity of admixed other component depending on the sensed purity.

Patentansprüche

1. Verfahren zum Trennen von Komponenten von einer flüssigen Mischung unter Verwendung eines Zyklontrenners, beinhaltend das Bestimmen der Effizienz der Trennung zumindest einer ersten der Komponenten von der Mischung und bei Bestimmung, daß die Effizienz von einem vorbestimmten Effizienzwert abgewichen ist, das Zugeben einer Quantität einer der Komponenten zu der in den Trenner eintretenden Mischung, um die Effizienz zum Zurückkehren auf den vorbestimmten Wert zu bringen, wobei die zugegebene Quantität von der Abweichung abhängt.

2. Verfahren nach Anspruch 1, bei dem die eine Komponente zugegeben wird, wenn die Effizienz in eine Richtung von dem vorbestimmten Effizienzwert abweicht, wobei das Verfahren ferner das Zugeben einer anderen der Komponenten zu der eintretenden Mischung, wenn die Effizienz von dem vorbestimmten Effizienzwert in einer der einen Richtung entgegengesetzten Richtung abweicht, beinhaltet.

3. Verfahren nach Anspruch 1 oder Anspruch 2, bei dem die erste Komponente die eine Komponente beinhaltet.

4. Verfahren nach Anspruch 1 oder Anspruch 2, bei dem die erste Komponente eine andere Komponente der Mischung als die eine Komponente beinhaltet.

5. Verfahren nach einem der Ansprüche 1 bis 4, ferner beinhaltend das Bestimmen der Effizienz der Trennung einer zweiten der Komponenten der Mischung und bei Bestimmung, daß die Effizienz der Trennung der zweiten Komponente von einem weiteren vorbestimmten Effizienzwert abgewichen ist, das Zugeben einer Quantität einer anderen Komponente als der einen Komponente zu der eintretenden Mischung, um die Effizienz der Trennung der zweiten Komponente zur Rückkehr auf den weiteren vorbestimmten Wert zu bringen, wobei die zugegebene Quantität von der Abweichung abhängt.

6. Verfahren nach Anspruch 5, bei dem die erste und die zweite Komponente die eine Komponente bzw. die andere Komponente oder die andere bzw. die eine Komponente beinhalten.

7. Verfahren nach einem der vorstehenden Ansprüche, bei dem die Mischung eine Öl-Wasser-Mischung ist, wobei das Öl und das Wasser dispergierte bzw. kontinuierliche Phasen der Mischung sind und die eine Komponente Öl beinhaltet.

8. Verfahren nach einem der Ansprüche 1 bis 6, bei dem die Mischung eine Öl-Wasser-Mischung ist, wobei das Öl und das Wasser kontinuierliche bzw. dispergierte Phasen sind und die eine Komponente Wasser beinhaltet.

9. Verfahren nach Anspruch 7 oder Anspruch 8, bei dem das Wasser in der Mischung überwiegt.

10. Verfahren nach einem der vorstehenden Ansprüche, bei dem die zugegebene eine Komponente durch Trennen aus der Mischung erhalten wird.

11. Trennvorrichtung, aufweisend einen Zyklontrenner mit einer Einlaßeinrichtung für eine zu trennende Mischung von Flüssigkeiten und zumindest zwei Auslässen (16, 18) zum Auslassen jeweiliger Komponenten der Mischung, welche Komponenten sich in der Dichte unterscheiden, wobei die Vorrichtung ferner eine Zuführeinrichtung (50, 52) zum Zuführen einer Quantität einer der Komponenten und eine Einrichtung (54, 56) zum selektiven Zumischen einer Menge der einen Komponente aus der Zuführeinrichtung (50, 52) zu der Mischung vor dem Einlassen in den Trenner aufweist, wobei die Vorrichtung ferner eine zum Ausführen der Zumischung der einen Komponente zu der Mischung auf eine zum Konstanthalten der Trenneffizienz zumindest einer ersten der Komponenten der Mischung geeignete Weise ausgelegte Steuereinrichtung (48) und eine Erfassungseinrichtung (38, 40) aufweist, die so angeordnet ist, daß sie dem getrennten Fluß der ersten Komponente zum Erfassen ihrer Reinheit ausgesetzt ist, wobei die Steuereinrichtung (48) auf die Erfassungseinrichtung (38, 40) zum Variieren

der Quantität der zugemischten einen Komponente abhängig von der erfaßten Reinheit anspricht.

12. Vorrichtung nach Anspruch 11, mit einer weiteren Zuführeinrichtung (50, 52) zum Zuführen einer Quantität einer anderen der Komponenten und einer Einrichtung (54, 56) zum selektiven Zumischen einer Menge der anderen Komponente von der weiteren Zuführeinrichtung (50, 52) zu der Mischung vor dem Einlassen in den Trenner (12).

13. Vorrichtung nach Anspruch 12, bei der die Steuereinrichtung (48) ausgelegt ist zum Ausführen der Zumischung der anderen Komponente zu der Mischung auf eine zum Halten der Trenneffizienz der ersten und/oder einer zweiten der in der Mischung enthaltenen Komponenten geeignete Art, wobei die Vorrichtung ferner eine weitere Sensoreinrichtung (38, 40) aufweist, die so angeordnet ist, daß sie dem Fluß der getrennten zweiten Komponente zum Erfassen ihrer Reinheit ausgesetzt ist, wobei die Steuereinrichtung (48) auf die weitere Sensoreinrichtung (38, 40) anspricht, um die Menge der zugemischten anderen Komponente in Abhängigkeit von der erfaßten Reinheit zu variieren.

Revendications

1. Procédé de séparation des composants d'un mélange liquide par emploi d'un séparateur cyclonique, comportant le fait de déterminer l'efficacité de la séparation d'au moins un premier des composants du mélange et, lorsqu'il est déterminé que l'efficacité s'est écartée d'une valeur prescrite de l'efficacité, d'ajouter au mélange arrivant, dans le séparateur, une quantité de l'un desdits composants pour tendre à faire en sorte que l'efficacité revienne à la valeur prescrite, ladite quantité ajoutée dépendant de l'écart.

2. Procédé selon la revendication 1, dans lequel on ajoute l'un des composants lorsque l'efficacité s'écarte, dans un premier sens, de la valeur prescrite de l'efficacité, le procédé comportant en outre le fait d'ajouter au mélange arrivant un autre des composants lorsque l'efficacité s'est écartée de la valeur prescrite de l'efficacité dans un sens opposé au premier sens.

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel le premier composant contient le composant dit l'un desdits composants.

4. Procédé selon la revendication 1 ou la revendication 2, dans lequel le premier composant contient un composant du mélange autre que le composant dit l'un desdits composants.

5. Procédé selon l'une quelconque des revendications 1 à 4, comportant en outre le fait de déterminer l'efficacité de séparation d'un second des composants du mélange et, lorsqu'il est déterminé que l'efficacité de séparation du second composant s'est écartée d'une autre valeur prescrite de l'efficacité, d'ajouter au mélange arrivant une quantité d'un composant autre que celui dit l'un desdits composants, pour tendre à faire en sorte que l'efficacité de séparation du second composant revienne à l'autre valeur prescrite, la quantité ajoutée dépendant de l'écart.

6. Procédé selon la revendication 5, dans lequel les premier et second composants contiennent les composants dits l'un et l'autre des composants, respectivement, ou bien l'autre et l'un des composants, respectivement.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le mélange est un mélange produit pétrolier-eau, le produit pétrolier et l'eau étant respectivement des phases dispersée et continue du mélange et le composant dit l'un desdits composants contient le produit pétrolier.

8. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel le mélange est un mélange produit pétrolier-eau, le produit pétrolier et l'eau étant respectivement des phases continue et dispersée et le composant dit l'un desdits composants contient l'eau.

9. Procédé selon la revendication 7 ou la revendication 8, dans lequel l'eau prédomine dans le mélange.

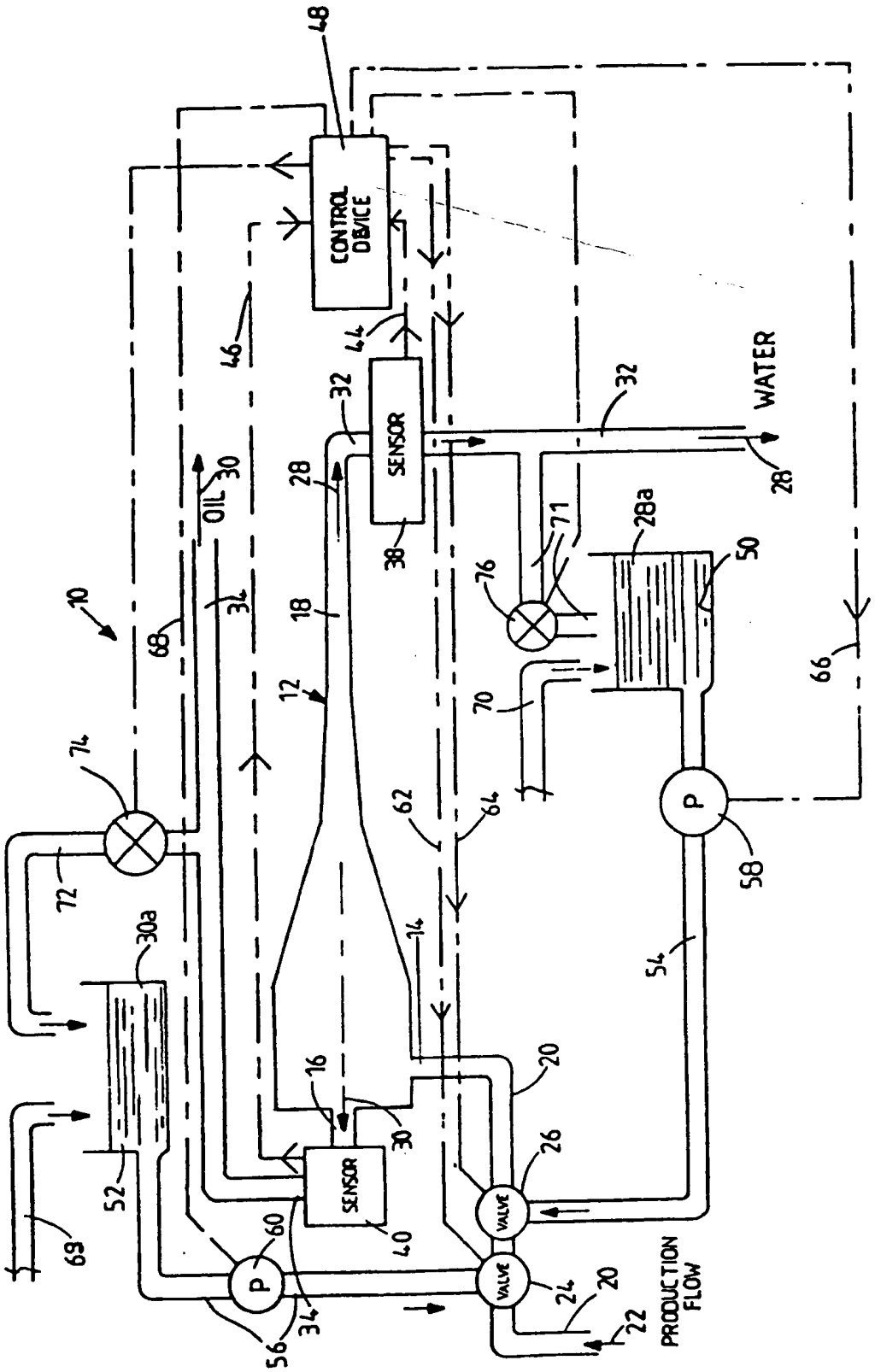
10. Procédé selon l'une quelconque des revendications précédentes dans lequel le composant dit l'un desdits composants, que l'on ajoute, s'obtient par séparation du mélange.

11. Appareil de séparation comportant un séparateur cyclonique présentant des moyens d'alimentation en mélange de liquides à séparer et au moins deux sorties (16, 18) pour faire sortir les composants respectifs du mélange, ces composants ayant des densités différentes, l'appareil comportant en outre des moyens d'introduction (50, 52) pour introduire une quantité de l'un desdits composants et des moyens (54, 56) pour mélanger sélectivement avec le mélange, avant introduction dans le séparateur, une proportion du composant dit l'un desdits composants en provenance des moyens d'introduction (50, 52), l'appareil comportant également des moyens de régulation (48) conçus pour opérer l'addition au mélange, et le mélange, du composant dit l'un desdits composants de façon tendant à maintenir constante l'efficacité de séparation d'au moins un premier desdits composants dudit mélange ainsi que des moyens de détection (38, 40) placés pour

être soumis au flux, séparé, dudit premier composant pour en détecter la pureté, les moyens de régulation (48) étant sensibles aux moyens de détection (38, 40) pour faire varier ladite quantité du composant dit l'un des composants, ajouté et mélangé, en fonction de la pureté détectée.

12. Appareil selon la revendication 11, comportant en outre des moyens d'introduction (50, 52) pour introduire une quantité d'un autre des composants et des moyens (54, 56) pour mélanger sélectivement au mélange, avant admission au séparateur (12), une proportion de l'autre composant en provenance des autres moyens d'introduction (50, 52).

13. Appareil selon la revendication 12, dans lequel les moyens de régulation (48) sont conçus pour opérer l'addition au mélange de l'autre composant, et son mélange, de façon tendant à maintenir l'efficacité de séparation du premier et/ou d'un second des composants que contient le mélange, l'appareil comportant en outre d'autres moyens de détection (38, 40) placés pour être soumis au flux du second composant, séparé, pour en détecter la pureté, les moyens de régulation (48) étant sensibles aux autres moyens de détection (38, 40) pour faire varier la quantité de l'autre composant, ajouté et mélangé, en fonction de la pureté détectée.


CONTROL DEVICE
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PRODUCTION FLOW
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